Evaluation of geriatric patients with carbon monoxide ıntoxication presenting to the emergency department

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Geriatric patients with carbon monoxide intoxication

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Abstract

Aim: In this study, we aimed to evaluate geriatric patients admitted to the emergency department with CO intoxication with regard to their demographic and epidemiological factors, and to assess changes in their inflammatory parameters.

Material and Methods: This was a retrospective study enrolling patients aged 65 years or older with a carboxyhemoglobin [COHb] level above 5%. The patients were grouped into 2 groups as mild to moderate/severe intoxication groups. Demographic, epidemiological data and inflammatory parameters were evaluated. A p-value of less than $p<0.05$ was considered statistically significant.

Results: This study included 95 patients. The mean COHb level of the patients was 24. Among the study population, 63.2% presented with mild intoxication and 36.8% with moderate-severe intoxication. A comparison of the inflammatory parameters with respect to intoxication severity and cardiac involvement revealed a significantly lower platelet-lymphocyte ratio [$p<0.001$], but significantly higher [$p<0.05$] other parameters in patients with moderate-severe intoxication and cardiac involvement.

Discussion: In the present study, in which we aimed to investigate CO intoxication in the geriatric age group, we found that CO intoxication in elderly patients had characteristics similar to those of the general population. Also, we observed significant changes in all systemic inflammatory parameters in moderate-severe intoxication cases compared to mild intoxication cases.

Keywords

Geriatric; Carbon monoxide intoxication; Inflammation

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Introduction

Carbon monoxide [CO] intoxication is one of the most common intoxications encountered in daily life and ranks at the top among suicidal and accidental intoxications resulting in death. The mode of clinical presentation ranges from headache to coma and death, and the mortality rate is between 1% and 3% [1].

Reversible carboxyhemoglobin [COHb] complex which is formed in the blood after exposure to CO, causes a reduction in oxygen-carrying capacity, impairs cellular oxidative metabolism and leads to tissue hypoxia. The latter results in increased oxidative stress at the cellular level and inflammatory processes, including the formation of endogenous free oxygen radicals [2-4].

Prior studies have defined the role of white blood cell [WBC], neutrophil-to-lymphocyte ratio [NLR], platelet-to-lymphocyte ratio [PLR], red cell distribution width [RDW] studied from peripheral blood as inflammatory marker and/or stress markers in various conditions. It is hypothesized that these inflammatory parameters may be used as potential markers to detect inflammation in various oncological and cardiac disorders [5-8]. The geriatric population makes up 6.2% of the global population. It is estimated that by 2050 geriatric population will reach 20% [2].

The need for emergency medical care and health resources increases in the elderly. It has been reported that the incidence and mortality and complication rates in the geriatric population differ from those in other age groups [9].

Factors such as age-related comorbidities, the sequelae of former surgeries, using multiple medications, and immune compromise lead to more atypical and severe disease courses in the geriatric population. Although elderly patients make up only a minority of intoxicated people, they suffer from a higher mortality rate that linearly increases with aging [10].

There is a small body of information in the literature on the incidence and course of CO intoxication in elderly persons. We, herein, aimed to evaluate geriatric patients admitted to the emergency department with CO intoxication with regard to demographic and epidemiological aspects, and to detect any changes in their inflammatory parameters.

Material and Methods

Study population

This was a retrospective study approved by the local ethics committee. All patients aged 65 years or older who presented to Keçiören Training and Research Hospital Emergency Medicine Clinic with CO intoxication between 01.06.2013-01.06.2018 were enrolled. The medical records of patients with carbon monoxide intoxication were scanned from the hospital automation system [Akgün Health Information System®]. Patients with a COHb level equal to or above 5% in blood gas analysis were enrolled.

Patients with missing data, oncological or hematological disorders, recent myocardial infarction [<30 days], immune suppression, chronic renal failure, severe liver disease were excluded. Demographic data, systemic and neurological examination findings, full blood count parameters studied after admission to the emergency department [hemoglobin, neutrophil count, lymphocyte count, platelet count, erythrocyte distribution width [RDW], serum troponin level, treatment modality applied [normobaric [NBOT] or hyperbaric oxygen therapy [HBOT]] were recorded.

The patients were grouped into two groups on the basis of intoxication severity as follows: a) Mild intoxication: patients with non-persistent symptoms who were responsive to NBOT; b) Moderate-severe intoxication: patients with protracted symptoms [chest pain, weakness, tachycardia, tachypnea] despite the administration of NBOT; those with life-threatening symptoms [hypotension, dysrhythmias, myocardial ischemia, noncardiogenic pulmonary edema, seizures, coma, cardiac arrest, respiratory arrest]; and those who have had indications for HBOT or have underwent HBOT. The patients were also categorized into two groups on the basis of cardiac involvement that is troponin positivity and ischemic ECG signs. Those with troponin positivity or ischemia on the ECG were considered to have cardiac involvement.

Laboratory parameters

Systemic inflammatory parameters [white blood cell [WBC], neutrophil/lymphocyte ratio [NLR], platelet/lymphocyte [PLR], red cell distribution width [RDW]] were evaluated in the complete blood count in geriatric patients. In our emergency department, venous blood samples were taken with heparin-containing syringes from patients with suspected carbon monoxide intoxication and studied with the Gestat 1825 [Japan] device. A complete blood count is studied with Abbott Cell Dyn 3700 [USA] device.

RDW, WBC were analyzed using an automated blood cell counter. NLR was calculated as the ratio of neutrophil count to lymphocyte count, the PLR was calculated as the ratio of platelet count to lymphocyte count. Troponin and biochemical parameters were studied with the Siemens ADVIA Centaur XPT immunoassay system [German] and the Beckman Coulter AU 5800 [Japan] device.

Statistical analysis

Study data were analyzed using IBM SPSS16.0 [Chicago, IL, USA] statistical software. The normality of discrete and continuous numerical variables was checked with the Shapiro-Wilk test.

Since the data did not meet the criteria for normal distribution, they were expressed as median and interquartile range [IQR, 25%–75]; categorical variables were expressed as number and percentage [%].

Categorical variables were compared between the groups using the Chi-square test and continuous variables using the Mann-Whitney-U test. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 104 geriatric patients were identified for enrollment. Among these, 9 were excluded due to having missing data or meeting exclusion criteria. As a result, a total of 95 geriatric patients were included in the study for statistical analyses. Fifty-one [53.7%] patients were women; the median age of the whole study population was 70 [IQR 25-75%: 66-78] years. The most common comorbidity was hypertension [62.1%]. The most common symptom was headache, observed in 59 [62.1%] patients. The mean COHb level of the patients was 24 [IQR 25-75] [18-34]. The demographics, vital signs, and laboratory findings of the whole study group are shown in Table 1.

The study population was categorized into two groups based on the intoxication severity, with 63.2% of the patients having had mild intoxication and 36.8% moderate-severe intoxication. Comparison of inflammatory parameters based on the intoxication severity revealed significantly lower NLR [p<0.001], but significantly higher other parameters [p<0.05] in the moderate-severe intoxication group than in the mild intoxication group [Table 2].

The study population was categorized into cardiac involvement-positive and negative groups based on troponin levels and ECG signs. Among those who had cardiac involvement, PLR was significantly lower [p<0.001] and other parameters were significantly higher [p<0.05] than in patients without cardiac involvement [Table 3].

The patients were categorized into NBOT and HBOT groups depending on the treatment applied. The HBOT group had significantly lower PLR [p<0.001], but significantly higher other parameters [p<0.05] [Table 3].

Table 1. Demographic properties of the study population

Age, Median [IQR 25-75]	70 [66-78]
Gender [male], n [%]	51[53.7%]
Comorbidity, n [%]	
Hypertension	59 [62.1%]
Diabetes Mellitus	22 [23.2%]
Atherosclerotic heart disease	9 [9.5%]
Heart failure	9 [9.5%]
Chronic obstructive pulmonary disease	6 [6.3%]
Other	16 [16.8%]
Carbon monoxide source n [%]	
Gas	58 [61.1%]
Coal	37 [38.9%]
Common presentation symptoms, n [%]	
Headache	59 [62.1%]
Nausea/vomiting	37 [38.9%]
Dizziness	22 [23.2%]
Syncope	6 [6.3%]
Others	33 [34.7%]
GCS score, Median [IQR 25-75]	13.67 [11-15]
Vital signs Median [IQR 25-75]	
Systolic blood pressure, mmHg	131 [114-148]
Diastolic blood pressure, mmHg	76 [64-88]
Pulse /minute	100 [88-114]
Oxygen saturation	92 [90-94]
Laboratory finding Median [IQR 25-75]	
COHB level	24 [18-34]
WBC [$10^3/\mu L$]	10 [7.4-14]
Neutrophil[$10^3/\mu L$]	3.97 [2.63-5.55]
Lymphocyte[$10^3/\mu L$]	1.8 [1.4-2.2]
RDW [%]	14.8 [13.1-16.1]
Platelet[$10^3/\mu L$]	223 [168-282]
Troponin ng/mL	0 [0-0.2]
NLR	3.97 [2.63-5.55]
PLR	118.88 [76.72-201]
Cardiac involvement n [%]	26 [27.4%]
Treatment, n [%]	
Hyperbaric oxygen therapy	33 [34.7%]
Normobaric oxygen therapy	62 [65.3%]
Patient outcome n[%]	
Dead	5 [5.3%]

GCS: Glascow Coma Score COHB: Carboxyhemoglobin WBC: White Blood Cell NLR: Neutrophil Lymphocyte Ratio PLR: Platelet Lymphocyte Ratio RDW: Red Cell Distribution Width.

Table 2. Laboratory findings of patients according to toxicity severity

Median [IQR 25-75]	Mildtoxicity [n=60]	Moderate-severe toxicity [n= 35]	p-value
COHB level	19 [16-24]	36 [33-40]	<0.001
WBC [$10^3/\mu L$]	8.25 [6.12-10.62]	14.4[12.6-16.8]	<0.001
Neutrophil [$10^3/\mu L$]	3.23 [2.21-4.42]	5.55 [3.97-7.20]	<0.001
Lymphocyte [$10^3/\mu L$]	1.60 [1.3-1.94]	2.1 [1.7-2.5]	0.002
RDW [%]	13.85 [12.8-14.97]	16.10 [15.40-16.60]	<0.001
NLR	3.23 [2.21-4.42]	5.55 [3.97-7.20]	<0.001
PLR	150.38 [99.1-219.68]	81.32 [51.25-124.44]	<0.001

COHB: Carboxyhemoglobin WBC: White Blood Cell NLR: Neutrophil Lymphocyte Ratio PLR: Platelet Lymphocyte Ratio RDW: Red Cell Distribution Width.

Table 3. Laboratory findings of patients according to cardiac involvement and treatment

Median [IQR 25-75]	Cardiac involvement			Treatment		
	Negative [n=69]	Positive [n= 26]	P value	NBOT [n=62]	HBOT [n= 33]	P value
COHB level	20 [16-27]	38 [34-41]	<0.001	19 [16-24]	37 [33.5-40]	<0.001
WBC [$10^3/\mu L$]	8.4 [6.4 to 11.35]	14.8 [12.75 to 16.9]	<0.001	8.25 [6.17-10.8]	14.8 [12.85-17]	<0.001
Neutrophil [$10^3/\mu L$]	3.5 [2.33-4.9]	4.95 [3.66-7.16]	0.007	5.66 [4.07-7.8]	10.8 [9.1-13.7]	0.007
Lymphocyte [$10^3/\mu L$]	1.7 [1.3-2]	2.1 [1.69-2.7]	0.002	1.63 [1.3-2]	2.1 [1.68-2.55]	0.005
RDW [%]	14 [13-15.25]	16.1 [15.37-17.77]	<0.001	13.95 [12.8-15.0]	16.1 [15.5-16.5]	<0.001
NLR	3.5 [2.33-4.9]	4.95 [3.66-7.16]	0.007	3.23 [2.21-4.44]	5.61 [4.05-7.28]	<0.001
PLR	143.87 [98.28-215]	63.17 [39.2-110.52]	<0.001	146.93 [99.7-219]	80 [50.6-128]	<0.001

COHB: Carboxyhemoglobin WBC: White Blood Cell NLR: Neutrophil Lymphocyte Ratio PLR: Platelet Lymphocyte Ratio RDW: Red Cell Distribution Width NBT: Normobaric Oxygen Therapy HBOT: Hyperbaric Oxygen Therapy

Discussion

The geriatric population is regarded as a group that requires a specialized approach to many disorders. CO intoxication, which causes the highest mortality and morbidity in the general population, should also be carefully investigated in the elderly [9]. In the present study, we aimed to investigate CO intoxication in a geriatric age group, where we observed a significant increase in all systemic inflammatory parameters among the elderly patients with moderate-severe intoxication compared to the ones with mild intoxication. We believe that this finding most probably stemmed from physiological compensatory mechanisms that lose their effectiveness with aging as well as a more profound systemic response to intoxication resulting in a more prominent increase in systemic inflammatory parameters. Considering this finding along with the inadequacy of COHb level alone to predict prognosis, we are of the opinion that systemic inflammatory parameters including NLR and PLR may guide clinicians to determine CO severity.

It has been reported in the literature that psychological and mental evaluation skills are impaired among the geriatric population as a result of both cognitive impairment processes and multiple chronic disorders [10]. As a result, relative incompetence to perceive and protect themselves from hazardous conditions may lead to a susceptibility to CO intoxication in this age group. Physiological handicaps secondary to advanced age lead to an expectation for more common complications and a greater mortality rate after CO exposure.

The rate of cardiac complications among the general population with CO intoxication is around 15-30 % [11, 12]. In this study, we revealed a mortality rate of 27.4%, which was similar to that in the general population. It is a well-known fact that the cardiopulmonary reserve of the geriatric population is reduced, which may result in a more severe cardiac involvement in this population than in other age groups [13]. However, we believe that such an assumption cannot be generalized to the whole geriatric population, since geriatric patients with comorbidities or susceptible to them have a wide age range and quality of care, as well as a variable physiological reserve; and when they suffer such disorders they are detected to be in variable stages of the disease. We believe that the rate of cardiac involvement demonstrated in this study supports this view. We observed the rates of 34.7% and 5.3% for HBOT need and mortality, respectively. Prior studies have reported highly variable rates for HBOT need and mortality for CO intoxication in the general population. Doğan et al. reported a rate of 32.4% for HBOT need, Emektar et al. 15%, Cervellin et al. 60.5%, and Jung et al. 87.5% [14-17].The reported mortality rates of CO intoxication range between 1% and 31% [18]. We believe that this heterogeneity including our study have stemmed from the heterogeneity of the study groups.

It has been stressed that COHb level alone is inadequate for predicting the complications of CO intoxication, including neurological sequelae [19, 20]. In contrast, NLR and PLR have been recently reported to be predictive of disease severity and prognosis in many systemic disorders affecting the general population [21, 22]. There is a limited number of studies exploring the role of those novel systemic inflammatory parameters in CO intoxication. A recent study by Han et al. reported that a higher admission NLR ratio and WBC count were predictors of myocardial injury in CO intoxication, with 4.83 being the optimal cut-off level for NLR with a sensitivity of 85.7% and a specificity of 45.4% [23]. We found significantly higher NLR level and WBC count among geriatric patients with cardiac involvement than in those without. Similar to the results reported by Han et al., we revealed an NLR level above 4.83 [4.95] in the cardiac injury positive group. Schnittger et al. studied the neutrophil responses of patients with CO intoxication who underwent HBOT; they reported that neutrophilia detected at the time of admission may be related to organ injury. Moreover, they advocated they HBOT did not reduce neutrophil count, but may have assumed a protective role against complications by mitigating neutrophil accumulation [24]. We detected significantly higher NLR levels in patients who underwent HBOT due to the presence or risk of organ dysfunction than in those who did not. In addition to these parameters, other systemic inflammatory parameters were also significantly different between the two treatment groups. This may be due to a limited compensation ability that leads to maximum response to minimum exposure in the geriatric population. Hence, excess responses in all systemic inflammatory parameters as a sign of a total inflammatory involvement seems to be the most plausible reason of our finding.

Our study had some limitations. Firstly, it was conducted in a single center, and thus its findings cannot be generalized to all centers. Secondly, as it had a retrospective design, it is possible that erroneous or missing data originated from the hospital automation system may have influenced our findings.

Inflammatory disorders are characterized by different complex processes, and the entirety of the inflammatory parameters attributed to those inflammatory processes was not studied in the present study. This may be considered the major limitation of our study.

CO intoxication features heterogeneity with respect to both general features and disease severity in the geriatric population like in the general population, which cannot be attributable to the characteristic regression of the elderly patients. Moreover, we observed significant differences in all systemic inflammatory parameters in the geriatric cases with moderate-severe intoxication than the mildly intoxicated ones. We are of the opinion that systemic inflammatory parameters including NLR and PLR may guide clinicians in detecting disease severity of CO intoxication.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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